



SUBSTITUTE SPECIFICATION

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~~HOLLOW MOLDED PART WITH CLOSED CROSS SECTION~~

~~AND A REINFORCEMENT~~

HOLLOW MOLDED PART MADE OF A METALLIC MATERIAL

IN THE SHAPE OF AN A-COLUMN FOR A MOTOR VEHICLE

AND A METHOD FOR ITS PRODUCTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The Invention relates to a hollow molded part in the shape of an A-column for a motor vehicle made of a metallic material produced by inner high pressure metal forming out of a mold blank and to a method of production of the hollow molded part, wherein the hollow molded part exhibits a closed cross-section and a reinforcement according to the preamble of the [[first]] Patent claims [[claim]].

2. Brief Description of the Background of the Invention Including Prior Art

A vehicle structural member or, respectively, a hollow molded part with closed cross-section is known from the German printed Patent document DE 19518946 A1, wherein the vehicle structural member or, respectively, the hollow molded part is formed with at least two component parts connected to each other. The term closed cross-section is associated with the circumference of the hollow mold part closed in itself. This hollow molded part represents a front column or, respectively, an A-column of a motor vehicle body and is formed out of an outer plate, a column stiffening and an inner column made of light metal. The reinforcement element is here disposed within the region of the closed cross-section of the vehicle structural member. It is furnished to attach several individual elements, such as for example pipes, plates, or the like along the hollow reinforcement element for further increasing the strength.

A solution is described in the German printed Patent document DE 10126183 A1, wherein a stiffening element is disposed in the inner chamber of the hollow molded part, wherein the stiffening element is connected to the hollow molded part and wherein the stiffening element extends through a recess of the hollow molded part into the inner space of the hollow molded part. The frame structure of a vehicle is described in the German printed Patent document DE 20 20 6524 U1, wherein a tubular frame part is furnished and wherein a sheet metal component part is furnished

at the outer circumference of the tubular frame part for reinforcement of the frame structure. The disadvantage of this solution comprises the multipart construction and the therewith associated high production expenditure.

The body of a motor vehicle is described in the German printed Patent document DE 4106501 A1, wherein a part of the supporting structure of the body is composed out of two extruder profiles open relative to each other, and wherein the extruder profiles exhibit a closed cross-section after a connection to each other. The extruder profiles are here weight optimized based on shape and wall thickness corresponding to the expected requirements as to stiffness. The multiple part construction of the respective frame part is here also disadvantageous.

The United States patent 6,553,243 B1 to Bignucolo et al. describes a method for the production of a front axle of a motor vehicle. A first pre-form with the center cylindrical region 3 is here produced out of a section by a radial forming method, wherein the center cylindrical region 3 exhibits two cylindrical ends 4, wherein the diameter of the two cylindrical ends 4 is smaller than the diameter of the center region 3. A frustro-conical shaped region 5 extends between the center cylindrical region 3 and each cylindrical end region 4. A second pre-form is produced by having the first pre-form pressed or upset in a press such that an elliptical cross-section 6b is generated in the center region 3, wherein a recess 6b is present at the two ends of the

elliptical cross-section 6b. Then according to a further pre-form step, a square cross-section 7a is formed in the center region.

Finally the production of the front axle occurs by inner high-pressure forming. This method requires overall four forming stages in order to form the front axle. The production of an A-column of a motor vehicle is not possible with the method according to Bignucolo et al., since a relatively strong bending is present in connection with the A-column and since Bignucolo et al. do not furnish a bending method.

A solution is described United States patent 5,823,031, by way of which method an expanding and bending of a tube becomes possible. The bent region joins at the expanded region. A wall thickness increase is not possible with the solution of United States patent 5,823,031. Also according to United States patent 5,823,031 the bending of the tube is not performed under the action of an axial pull tension. The production of an A-column of a motor vehicle with the reinforcement region is not possible with the solution of United States patent 5,823,031.

It is an object of the present Invention to furnish a method for the production of a hollow form part.

SUMMARY OF THE INVENTION

1. Purposes of the Invention

It is an object of the Invention to develop a method of production of a hollow molded part made out of a metallic material in the form of an A-column for a motor vehicle ~~with a closed cross section and a reinforcement~~, which hollow molded part can be produced out of a minimum number of component parts.

These and other objects and advantages of the present invention will become evident from the description which follows.

2. Brief Description of the Invention

The present invention provides a method for producing a hollow molded part made out of a metallic material in the form of an A-column for a motor vehicle with closed cross-section and a reinforcement.

This object is accomplished with the features of the [[first]] Patent claims [[claim]] and further features result from the subclaims. The A-column ~~hollow molded part made of a metallic material, which hollow molded part~~ is produced out of a mold blank by inner high pressure metal forming and exhibits here a closed cross-section and a reinforcement and is formed as a single part with the reinforcement.

~~Here a blank mold is generated having a first region, wherein the first region exhibits a first starting outer diameter and a starting wall thickness and with at least one second region reduced relative to the starting outer diameter, wherein the second region exhibits an increased wall thickness relative to the starting wall thickness, wherein the region of the increased wall thickness forms the reinforcement.~~

~~The second region is here preferably conically formed. A third region with reduced diameter can follow to the second region, wherein the third region then also exhibits an increased wall thickness in comparison to the starting wall thickness.~~

The second conical region and as far as present also the third region are reduced in their diameter here by a radial or tangential deformation method in comparison to the first region. This is accomplished preferably by hammering, forging, rotary kneading, swaging, rolling, flow turning or stretch forming.

~~It is also possible that a conical second region and a region reduced in diameter follow right and left mirror imaging to the first region with the larger outer diameter or that a region reduced in diameter is disposed in the middle, wherein a conical~~

~~region with following increased starting diameter follows on two sides to the region reduced in diameter and disposed in the middle.~~

The hollow molded part is preferably bent in the second conical region for production of ~~for example~~ an A-column of a vehicle body.

It is for the first time possible based on the wall thickness increase in the reduced region to produce a single part A-column ~~frame part with reinforcement~~. A blank mold is generated by rotary kneading out of a tubular starting part with a starting wall thickness for production of ~~for example~~ an A-column, wherein the blank mold exhibits a region with an a starting diameter, a conical region (narrowing in diameter) and a cylindrical region following and having a reduced diameter, wherein the wall thickness is increased in the conical region and in the diameter reduced region relative to and in comparison with the starting wall thickness. The mold blank is in the following bent in the conical region (preferably subject to axial tensile stress).

Finally the A-column is produced by inner high-pressure metal forming. Several intermediate deformation stages can be performed prior to the bending and/or prior to the inner high-pressure metal forming. It is also possible to

intermediately anneal the in part produced workpiece prior to the inner high-pressure metal forming.

Larger loads in the crash case can be taken based on the increased wall thickness in the conical region also with single part formation.

~~It is also possible with the construction according to the present invention to produce for example longitudinal carriers, frame parts, axial bodies and gear parts, wherein an increased wall thickness or, respectively, reinforcement in certain regions of these could be achieved up to now only by multipart construction, wherein consideration is given to increased load requirements in particular in the narrowing region of the mold blank or of the therefrom generated hollow mold part based on the increased wall thickness.~~

The advantages of an increased strength and an increased wall thickness in the deformation region, of a relative smooth surface, of a favorable course of the fibers, as well as of time savings and material savings appear by employing round kneading, where round kneading is a chipless and shavingless deformation process for reducing the cross-section of rods, tubes and wires.

The materials employed for production of the hollow mold part according to the present invention include steel, stainless steel, non-iron metals and/or alloys.

The Invention is illustrated in more detail in the following based on the embodiment examples and associated drawings.

The novel features which are considered as characteristic for the invention are set forth in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing, in which are shown several of the various possible embodiments of the present invention:

There is shown in:

Figure 1: a side elevational view of a tubular starting part for production of a hollow molded part in the shape of an A-column,

Figure 2: a sectional view of a mold blank for production of a hollow molded part in the shape of an A-column,

Figure 3: blank mold which had been bent ~~for production of an axle,~~

Figure 4: an A-column ~~[[axle]]~~ produced from a blank mold by an inner high-pressure metal forming process.

Figure 1 shows the tubular starting part A with a starting outer diameter $D1$, which tubular starting part A serves for example for production of an A-column of a vehicular body. A first mold blank V1 for further production of the hollow molded part in the shape of an A-column was generated for example by rotary kneading in a round kneading machine according to figure 2. The A-column exhibits a cylindrical first region 1 with the length $L1$, wherein the diameter of the cylindrical first region 1 corresponds to the starting outer diameter $D1$ and which first region 1 has a starting wall thickness $b1$. There follows a second region 2 of a length $L2$, wherein the outer diameter reduces conically up to the outer diameter $D2$. The angle α depends here on the starting outer diameter $D1$, on the outer diameter $D2$ and on the length $L2$ of the region 2. The following third region is formed cylindrical and is reduced to the diameter $D2$ over a length $L3$. The wall thickness $b2$ of the following third region 3

and also the wall thickness not designated in detail for the second region are increased in comparison to the starting wall thickness b_1 . The wall thickness of the second region corresponds to the wall thickness b_1 or, respectively, b_2 in the transition areas to the regions 1 or, respectively, 3.

The first mold blank V1 is now bent to a second mold blank V2 (Fig. 3) according to the required curvature of the A-column, wherein the bending radius R is disposed in the second region (~~not illustrated~~). Finally, the final forming of A-column S (Fig. 4) is performed by inner high-pressure metal forming as applied to the second mold blank V2. Several intermediate deformation stages (not illustrated) can be performed previously and possibly an annealing treatment can be performed. The finished A-column S (Fig. 4) exhibits now in the region of the bending (previously region 2) and in the following region directed toward the roof of the vehicle (previously region 3) an increased wall thickness b_2 as compared with the wall thickness b_1 in the region 1, wherein the increased wall thickness operates as a reinforcement and whereby further internally disposed or from the outside applied additional reinforcement parts can be dispensed with.

The dimensions of the mold blank V illustrated in Fig. 2 can assume thereby the following dimensions:

- starting diameter D_1 : from about 80 mm to 160 mm,

- outer diameter D2: from about 0.4 to 0.7 times the size of the starting diameter D1,
- starting wall thickness b1: from about 2.0 mm to 5.0 mm,
- wall thickness b2: from about 0.4 to 0.7 ~~divided by~~ times the starting wall thickness b1,
- length L1: from about 1000 mm to 2500 mm,
- length L2: from about 200 to 1000 mm,
- length L3: from about 500 mm to 1500 mm, and
- angle $\alpha = f(L2, D2, D1)$ = from about 10 degrees to 85 degrees.

It is to be noted at this point that in addition to the recited dimensions also mold blanks or, respectively hollow mold parts can be produced having a total length ($L1 + L2 + L3$) of from about 30 mm to 50 mm.

~~According to a further embodiment, a blank mold V can be generated out of a starting part A according to figure 3 for production of a single piece axle, wherein the mold blank V as seen from the middle (only a very narrow first region 1) exhibits two mirror image forming narrowing regions 2 and cylindrical third regions 3 reduced in diameter and following to the regions 2. A further region 3a having an outer diameter D3 with reduced diameter is present at the two ends. Here again the wall thickness is increased in the second regions 2 and in the~~

~~third regions 3 and 3a in comparison to the starting wall thickness b1 in the first region (middle). The forming of the first region 1 and of the two second regions 2 of the axle As according to figure 4 is performed in the following by inner high-pressure metal forming. Cracks are avoided during the inner high-pressure metal forming based on the larger wall thickness in particular in the regions 2 of the blank mold obtained in the process of rotary kneading and sufficient material is furnished for continued flow. The transition from the deformed region 4 to the adjoining regions 3 sustains higher loads based on the larger wall thickness acting as a reinforcement.~~

~~— Such hollow mold parts can be employed for example also in the production of gear parts in addition to the above described embodiment examples.~~

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of A-column tubular system configurations and metal processing A-column production procedures differing from the types described above.

While the invention has been illustrated and described as embodied in the context of an A-column ~~a hollow mold part with closed cross-section and reinforcement~~, it is not intended to be limited to the details shown, since various

modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

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